

## Converting to compact fluorescent lighting – a refurbishment guide



How to make your existing lighting energy efficient

### What is energy efficient lighting?

It is lighting which is EFFECTIVE in providing the appropriate lighting conditions when and where required, using the least amount of ENERGY and requiring the minimum effort to MAINTAIN.

### How can energy efficient lamps help?

Compact fluorescent lamps (CFLs) use up to 80% less energy than common tungsten general lighting service (GLS) lamps and can last up to 10 times longer – saving ENERGY and reducing MAINTENANCE. They are available in a wide variety of sizes and ratings as illustrated at the bottom of pages 2 to 6.

### What else do we need to know?

Choosing the correct rating, size and type of CFL for your specific needs can help you

achieve an ENERGY EFFICIENT lighting system. However, other issues include the choice of light fittings, controls, and whether to convert or renew your existing light fittings.

The case for energy efficient lighting is well proven. The problem is how to achieve it. Firstly, it is important to understand the principle.

### THE PRINCIPLE

Fluorescent lighting represents an entirely different and more efficient form of lighting than that from tungsten lamps. The CFL is a miniature version of the standard well-known fluorescent tube, and was developed as a replacement for the common tungsten GLS lamp.

Although the CFL is similar, and is a step forward in replacing the older and less efficient tungsten lamp, it is different and will therefore not produce the same type of light, give the same intensity, or distribute light in the same way.

Since CFLs are less intense than equivalent tungsten lamps (thereby having less penetration through many types of light fittings), it is sometimes advisable to use a lamp type of a higher lumen, or light output equivalent, than the original GLS lamp. This does not mean that more energy will be consumed. In fact less will be consumed.

In most cases, the CFL can equal or improve on the lighting of tungsten lamps, despite the differences, if the most

**“How to get the best out of compact fluorescent lighting”**



appropriate techniques are employed. An adjustment in thinking is therefore needed.

When tubular fluorescent lamps were first introduced, they were a different shape (too long, different socket, etc) to the standard tungsten lamps they were replacing. Alternative, more appropriate light fittings were developed to enable the significant benefits of the fluorescent lamp technology to be more widely realised. A similar approach should be considered when changing from tungsten to CFL technology.

### CONVERT, RENEW OR PLUG-IN?

When changing from standard tungsten lamps to CFLs the first consideration is whether to convert, renew or use a plug-in replacement lamp in the existing light fittings.

#### Conversion

There are three main components to a CFL: the actual lamp (or tube), the lampholder and the control gear (incorporating the ballast) which operates the lamp. Conversion by using a suitable ballast, lampholder and CFL is generally a very cost-effective, long-term refurbishment option, although once a conversion has been made, the flexibility of using another lamp type in the fitting is lost. The type of CFL which is operated by a separate control gear (lamp types 1 to 5 - see figure 3) can cost about one-third of CFLs with electronic integrated control gear (lamp types 6 to 11 - see figure 3). Therefore, using a system with separate control gear keeps the cost of replacement lamps low, and ensures a permanent change to energy efficient lighting (since the CFL cannot be replaced by a tungsten lamp at a later date).

To convert a fitting, the existing bayonet or Edison screw lampholder must be replaced with a suitable CFL lampholder, of the correct size and rating. The required lamp rating must first be decided and the appropriate CFL lampholder must then be matched to it. Generally, different types and ratings of CFLs and their lampholders are not interchangeable. A ballast is also required to operate the lamp. The ballast utilised can be separate from the lampholder or combined with it in one unit, commonly known as a 'combi'. For most conversion situations either electronic or electromagnetic ballasts can be used. When converting a fitting, the existing lampholder(s) should be removed (although this may not always be necessary if there is a lot of space available within the fitting).

Some manufacturers produce complete conversion kits for fittings which provide all the necessary components. Alternatively, components can be purchased separately. Whichever means are adopted, all conversion

work should be undertaken by a qualified electrician, ensuring that the wiring complies with the relevant Institution of Electrical Engineers requirements. Where a fitting is converted to take a CFL it is important that the new lamp is mounted in a similar position to the original GLS lamp. The converted fitting will operate at considerably lower temperatures, so the existing wires (if in suitable condition) could be re-used.

#### Renewal

The renewal of light fittings to those which are designed for CFLs is not necessarily as cost-effective as the conversion of existing fittings. However, if the light fittings are being replaced anyway, choosing a fitting which is designed for CFLs can prove to be an appropriate highly cost-effective solution (as indicated in figure 2).

Wholesalers now supply more styles and types of fitting specifically designed for use with CFLs. Some suppliers are prepared to supply standard fittings modified to take CFLs. Each manufacturer will often produce specifically for their particular type of market which may tend toward either a more technical or aesthetic approach (although some products achieve both of these criteria). Although the appearance of the fitting is often a key consideration, it is also important to ensure it is suitably designed for maximising light output. No light fitting emits 100% of the light produced by a light source; however, some are much more effective than others. The light output ratio of a fitting is a measure of how much light is emitted and is often provided in lighting catalogues, or directly available from the manufacturer. As a guide a minimum of at least 50% of the light produced by the lamp should be emitted from the light fitting. Light fittings incorporating glass covers often prove the most suitable in allowing maximum light output. If plastic covers are required, those of a UV stabilised type should always be chosen since other plastics can go brown very quickly when exposed to UV light. In areas where vandalism needs to be considered polycarbonate covers are recommended.

#### Plug-in replacement

The single unit direct plug-in CFL (with either bayonet or screw cap) represents a quick, and often practical, method of utilising energy efficient lighting (lamp types 6 to 11). If lights are operated for 4 hours or more it is not generally as cost-effective as conversion of light fittings, in the longer term, since the integral control gear is discarded at the end of the lamp life. It is now possible to purchase two-piece, plug-in CFLs, with the lamp separate from the control gear. Lamp types like those shown in figure 3 (types 1 to 4) can be purchased with a plug-in adaptor. In this case the gear generally lasts approximately three times the life of the lamp, and hence can prove a more cost-effective option than

purchasing the integral unit. When using a plug-in CFL, care must be taken to choose a lamp that does not protrude from the shade and that also emits sufficient light. For these reasons, certain shades or fittings will not be suitable for plug-ins and conversion or renewal should be considered.

#### CHOOSE RIGHT

Specifying the right energy efficient lighting requires choosing the right CFL, with the right control gear, in the right fitting. Other considerations include colour and switching controls (detailed on the back page).

#### Choice of control gear

All CFLs require some form of control gear for operation. There are two types of gear to consider, those:

- which incorporate electromagnetic ballasts
- with electronic types.

Both of these can be either separate or integral to the lamp (figures 3 and 4). Note: when utilising separate control gear, a CFL type lampholder is required, examples of which are shown in figure 5. The electromagnetic ballast operates at 50 Hz and is heavier and larger than the electronic ballast. These come in many sizes and ratings, the most popular of which are identified in figure 4. This ballast will 'flicker start' or 'hard start' a CFL and consumes approximately 4 W of energy additional to the lamp rating.

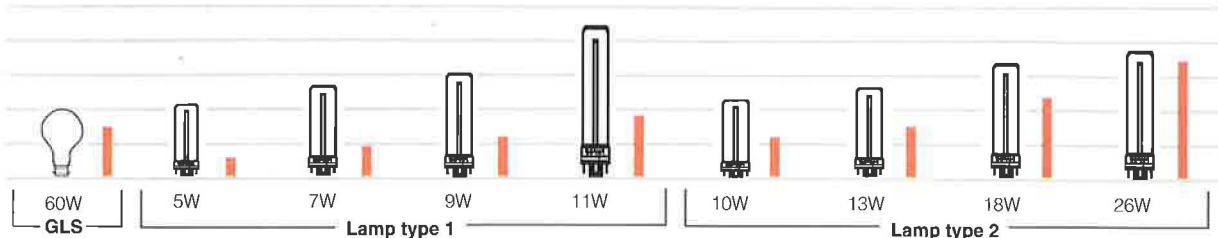
The electronic ballast operates at frequencies up to 40 kHz, thus reducing general flicker effects when running. This ballast will pre-heat the electrodes (known as 'soft start') and switch on the lamp almost instantaneously. This generally has a less damaging effect on the lamp and increases the lifetime of the CFL by up to 50%. An electronic ballast consumes approximately 2 W of energy. However, it optimises the power consumption of the lamp, generally running it at a slightly lower rating than the stated wattage. Hence, the net consumption is usually no larger than the rated wattage of the lamp. Twin lamp versions are also available for use with more than one CFL.

#### Choice of colour

Unlike the standard tungsten lamp there are a number of different colour 'whites' (or colour appearances) available in CFLs. Different appearances are suited to different lighting applications. The 'warm' white is the nearest to standard tungsten lighting, 'medium' white or 'cool' white give a progressively bluer light. All of these appearances refer to the light as it appears on a white surface. The colour rendition of modern CFLs (ie the degree to which they correctly reproduce colours) is a

DIMENSIONS (MM)	300	L 3000
	250	G 2500
	200	H 2000
	150	O 1500
	100	OUT 1000
	50	500
	0	0 (LUMENS)

#### Types of lamps and ratings available



significant improvement over that of earlier units and now they produce an almost identical effect to that of the GLS tungsten lamp.

#### Lifetime

The light output from CFLs slowly reduces over their lifetime slightly more than tungsten lamps, somewhat reducing their effectiveness with time. The useful life of a CFL is generally accepted to be the time at which the light output drops to 80% of the light level at 2000 hours. Manufacturers quote lifetimes of between 8000 and 12 000 hours depending on the lamp and control gear chosen. CFLs will usually continue to operate at reduced light outputs for considerably longer than the quoted lifetimes. This factor should be taken into consideration when assessing any need for relamping since although lamps may appear to be fully operational, required lighting levels may not be achieved.

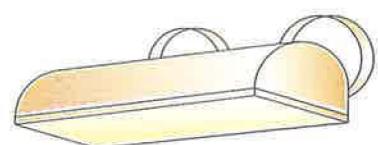
#### Frequency of switching

Lifetime also depends on the number of times the lamp is switched on and off. If, under normal operation, a lamp is regularly switched on and off at intervals of 2.5 minutes or less its lifetime can be considerably reduced. If electronic control gear is used to soft start the lamp this problem can be alleviated. However, in locations where

lighting is operated for very short periods with frequent switching (eg WCs and bathrooms) CFLs are not generally recommended since

they take a couple of minutes to warm up and reach full light output, by which time the light is often no longer required.

## UPLIGHTERS AND PICTURE LIGHT FITTINGS



#### Conversion

It is usually easy to convert either an uplighter or a picture light fitting since there is often adequate space inside the fitting for either a 'combi' integrated lampholder and ballast (figure 4c or 4f), or split control gear. Some uplighter fittings can even accept two or three sets of equipment, allowing substantial increases in light output to be achieved. If the light fitting is very small, a conversion using a separate CFL lampholder (figure 5a and 5b) and ballast (figure 4a or 4b) mounted remote from the fitting can be used. The output from either an uplighter or a picture light can also be improved by mounting a reflector behind the CFL to emit more of the light produced.

#### Renew

There are many new uplighters and picture lights now available from wholesalers for different sizes and types of CFL. In the case of picture lighting, selecting a lamp with good colour rendering properties will enhance the picture, and fittings with glass covers will reduce the effects of UV light on the picture being lit.

#### Plug-in

It is possible to use most types of plug-in CFLs in an uplighter. As the picture light does not generally use either a bayonet or Edison screw lampholder, plug-in lamps are not suitable for this application.

#### Cost-effectiveness

Figure 1 shows the relative cost-effectiveness of the various options by assessing the proportion of benefit to cost over a 10-year period. The graph is based on estimated wholesale CFL capital costs (£11.50 for conversion; £37.50 for renewal; and £11.75 for both types of plug-in replacement lamp) and capital cost of 25p for a GLS lamp. Labour for conversion and renewal is estimated at £6 and £4 per fitting respectively. A wholesale cost of £4 per replacement lamp is assumed for all but the single unit plug-in option. Savings are based on an average electricity cost of 6p per kWh, CFL life of 8000 hours, GLS lamp life of 1000 hours and a reduction in consumption of 45 W (ie the difference between a 60 W tungsten lamp and the equivalent 15 W CFL). All costs and savings are assessed at their net present value over a 10-year period assuming a Test Discount Rate of 6%.

The graph indicates that for lights regularly operated over longer periods both conversion and renewal are more cost-effective than single unit plug-in replacement (due to the reduced cost of replacement lamps). The cost-effectiveness of the single unit plug-in option remains roughly independent of operating hours (due to the relatively high cost of replacement lamps).

Clearly, other considerations outside of the scope of this graph will also affect the decision being made. In the case of renewal, if fittings are already near the end of their useful life only the over-cost of replacement with suitable luminaires should be considered, in effect creating a more practical, cost-effective option than conversion. The cost-effectiveness of making the decision to change to energy efficient fittings in this situation is illustrated by the payback graph in figure 2. Again, cost-effectiveness clearly depends on lamp operating hours.

As an example, if a light is regularly operated for 14 hours a day, by converting the fitting to use a CFL, savings will be worth more than 4.5 times the overall investment over a 10-year period. A two-piece, plug-in replacement will save about 2.5 times the overall investment.

Renewal will save over 3 times the investment and, if fittings are due for replacement anyway, the over cost of choosing a fitting designed for CFLs will pay back in less than a year.

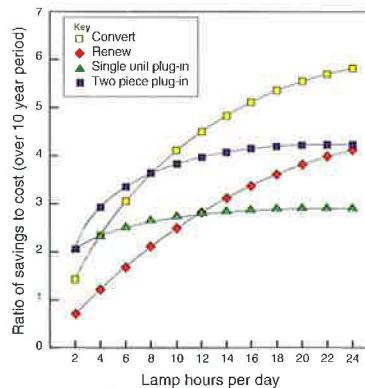


Figure 1 Cost-effectiveness of refurbishment options over 10-year period

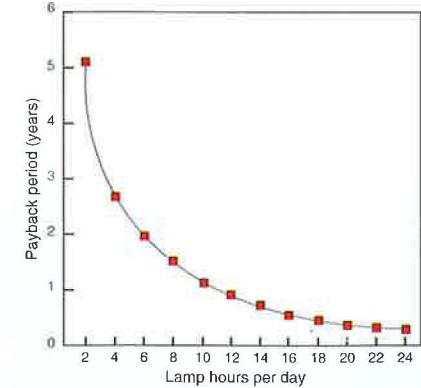
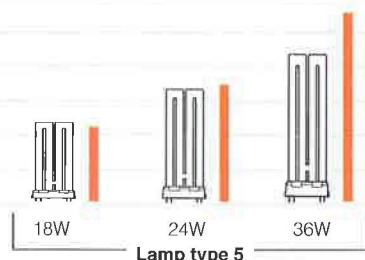
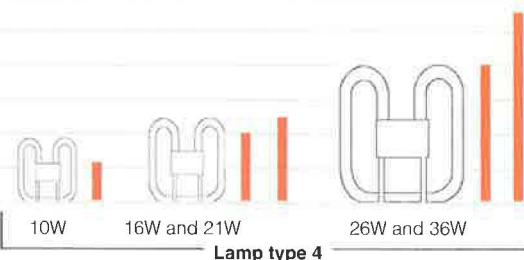
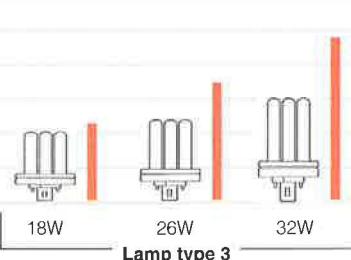
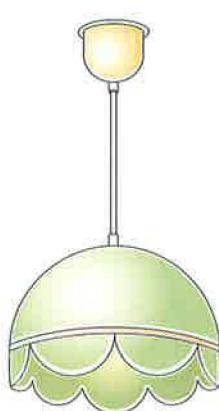


Figure 2 Payback on over cost of new fitting



## PENDANTS

**Conversion**

Pendant fittings may have a single drop, multiple drops or be multi-armed. It is possible to convert them using a 'combi' CFL integrated lampholder and ballast (figures 4c or 4f), or with separate CFL lampholder (5a and 5b) and ballast (figures 4a or 4b) mounted remotely in the ceiling rose or the ceiling void. If the control gear is to be mounted within the ceiling void the ballast should be enclosed within a container.

In some cases, when converting a pendant fitting it may be necessary to slightly increase the hole in the lamp shade to fit the CFL lampholder. For multi-drop or multi-arm pendants, ballasts are available which operate more than one lamp simultaneously. In all cases care must be taken to choose a CFL which is neither too long nor too large for the fitting, or too heavy for the wire.

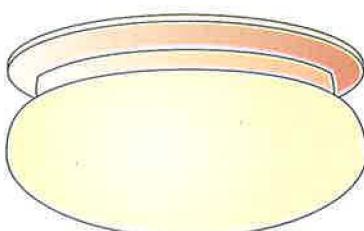
**Renew**

A number of single and multi-arm pendants designed for use with CFLs are now available.

**Plug-in**

Plug-in CFLs with electromagnetic ballasts are generally unsuitable for use in some pendant fittings since they are too heavy or too large for the shade.

## CEILING AND SURFACE MOUNTED FITTINGS

**Conversion**

It is possible to convert a ceiling or surface mounted fitting to utilise CFLs successfully by using either a 'combi' integrated CFL ballast and lampholder (figures 4c or 4f) or a separate lampholder (figures 5a and 5b) and ballast (figures 4a or 4b). When installed, all

components used should be firmly secured to the backplate of the fitting. Additionally, a reflector can be mounted on the backplate, behind the lamp(s), to increase light output from the fitting or at least ensure that the internal surfaces of the luminaire are of high reflectance.

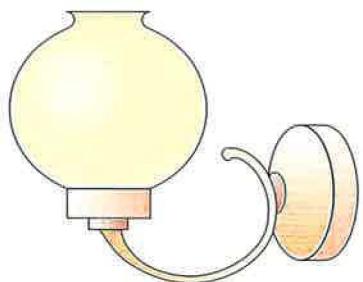
**Renew**

Considerable numbers of ceiling and surface mounted fittings designed for use with CFLs are now available.

**Plug-in**

Some types of plug-in CFL may be too large or too heavy for some ceiling or surface mounted fittings. In these cases alternative shorter versions may be available.

## WALL LIGHT FITTINGS

**Conversion**

It is possible to convert a wall light fitting using a 'combi' integrated ballast and lampholder (figure 4c or 4f). However, this will raise the position of the CFL in the fitting and consequently the overall height of the gear should be calculated to avoid the lamp protruding from the top of the shade. The other method of conversion involves mounting a separate ballast (figures 4a or 4b) either in the backplate or in the wall, and replacing the existing lampholder with a CFL lampholder of an appropriate rating (figure 5a and 5b).

**Renew**

Considerable numbers of wall light fittings designed for use with CFLs are now available.

**Plug-in**

Some types of plug-in CFLs are too long or too heavy to fit within the shade of most wall fittings. For this type of fitting small versions are advisable.

## TABLE, STANDARD AND DESK LAMPS

**Conversion**

It is possible to convert a table, standard or desk lamp to utilise CFLs successfully by fitting a CFL lampholder (figure 5a and 5b), and mounting separate ballast (figures 4a or 4b) in the lamp base. Similarly, the standard plug at the end of the existing lead could be replaced by a plug with integral ballast (figure 4d).

Alternatively, a 'combi' CFL integrated lampholder and ballast (figures 4c or 4f) can be used thereby providing a complete conversion within the head of the fitting.

Care needs to be taken to ensure that the CFL is not so long that it protrudes from the top of the shade. The floor mounted standard lamp could also be converted in a similar way and

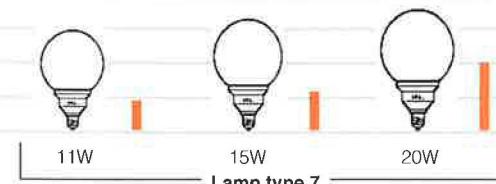
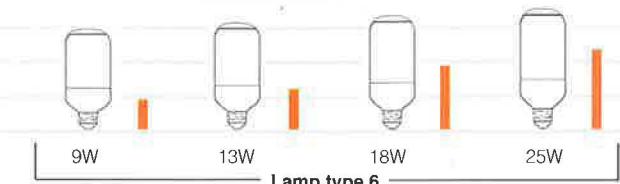
may provide a better opportunity for using the larger sizes of CFLs. When converting a desk lamp care must be taken to avoid making the lamp head top heavy.

**Renew**

There are probably more desk lamps available designed to take CFLs than any other type of fitting. Also many models of standard lamps can be ordered with CFLs.

**Plug-in**

Some types of plug-in CFLs are unsuitable for table and desk lamps as they are either too long or too heavy to fit within the space inside the shade. Those with electromagnetic ballasts are heavy and may unbalance the light fitting.



DIMENSIONS (MM)	LIGHT (LUMENS)
300	3000
250	2500
200	2000
150	1500
100	1000
50	500
0	0

## CEILING/WALL MOUNTED BULKHEADS



### Conversion

It is possible to convert exterior bulkhead fittings for use with CFLs using the same approach as conversion of ceiling and wall mounted internal fittings. There is often adequate space within exterior bulkhead fittings to allow use of the larger CFLs with higher light output than the original GLS lamp. This upgrading is particularly recommended if the existing cover restricts the light output considerably.

### Renew

There are a large number of ceiling and wall mounted exterior bulkhead fittings now made for CFLs. Since extreme temperatures can affect the light output from CFLs, fittings should be chosen which are well insulated and wherever possible operate the CFL with the lamp cap down (since the cap produces heat which then rises to warm the whole of the lamp, leading to more efficient operation).



### Plug-in

Some types of plug-in CFLs may be too large or too heavy for some wall or surface mounted bulkhead fittings.

## POWER FACTOR

Both electronic and electromagnetic ballasts for fluorescent lamps are inductive devices and cause the voltage and current in a circuit to become out of phase. This results in the lamp drawing more current than it would otherwise. The level to which this occurs is identifiable by the power factor of the lamp. For a GLS lamp the power factor is 1 (it uses the same power as its wattage). For a CFL the power factor can be as low as 0.5, indicating that significant extra current is drawn.

If required, the power factor can be improved using a capacitor either in the circuit as a whole or within each individual conversion. The value of the capacitor is dependent on the ballast operating the circuit. In general, if large numbers of CFLs are to be used in an installation a power factor of 0.9 or more is recommended.

## BOLLARDS



### Conversion

It is relatively straightforward to convert a bollard fitting by using either a 'combi' integrated CFL lampholder and ballast (figure 4c or 4f), or a separate CFL lampholder (figures 5a and 5b) and ballast (figures 4a and 4b). To maximise the light output from a bollard it is recommended the CFL be situated centrally in the lens area of the fitting.

### Renew

The majority of bollard light fittings currently available are designed to take CFLs or other high efficacy lamps and hence specification of such fittings is straightforward.

### Plug-in

Most of the plug-in types of CFLs are suitable for use as replacements for tungsten lamps in older styles of bollard. When specifying a plug-in replacement, care should be taken to ensure the lamp sits in the centre of the fitting to maximise light output.

## DIMMING CFLs

It is possible to regulate the light output from some CFLs using dimming controls, but only by using a suitable regulating or dimming ballast and lamp combination. Dimming cannot therefore be achieved using direct plug-in CFLs.

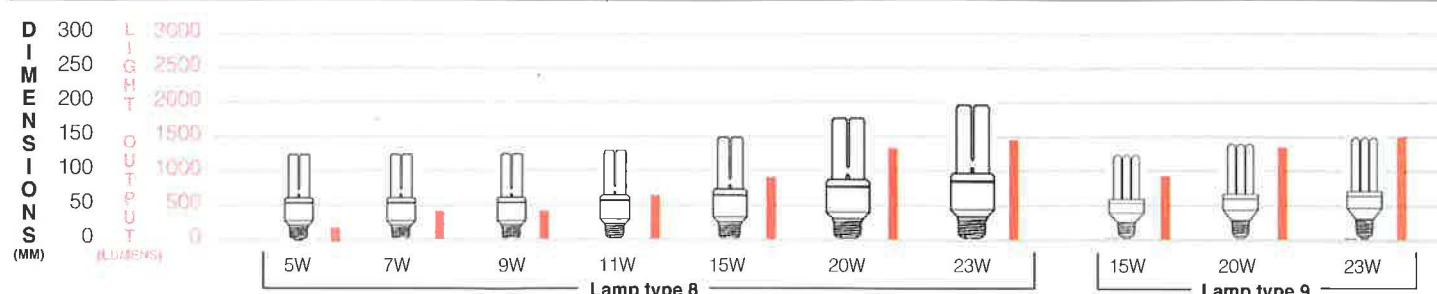
Special electronic dimming ballasts are usually more suitable and can, in some instances, be used to control more than one lamp simultaneously.

## MANAGEMENT CONTROLS

There are a number of energy management/lighting control systems that range from the relatively simple, which can switch off lamps by momentarily interrupting the supply voltage, to those that operate through sophisticated signalling systems. However it is essential to seek expert advice on this topic.

Figure 3 Summary of types of CFL

CFLs for use with separate gear				CFLs with integral gear (plug-in lamps)						
Type 1 Two-finger tube	Type 2 Four-finger tube	Type 3 Triple loop/triple two-finger tube	Type 6 Enclosed with electromagnetic ballast	Type 7 Enclosed with either electronic or electromagnetic ballast	Type 8 Four-finger tube with small electronic integrated ballast	Type 9 Triple loop/triple two-finger with electronic integrated ballast	Type 10 Four-finger tube with large electronic integrated ballast	Type 11 Circular tube with integrated electronic ballast		
Type 4 2D shape tube	Type 5 Four-finger tube									



## TECHNICAL INFORMATION

Figure 4 Types of separate control gear available

Figure 4a. Short cube ballast  
Sizes from 50 mm x 40 mm x 30 mmFigure 4b. Wafer ballast  
Sizes from 155 mm x 140 mm x 20 mm

Figure 4c. Combined 'combi' ballast C/W lampholder sizes from 155 mm x 140 mm x 58 mm



Figure 4d. 'Plug' with integral ballast



Figure 4e. Electronic integrated ballast within suspended lampholder - 100 mm long 58 mm dia.



Figure 4f. Electronic integrated ballast with lampholder - 57 mm dia. x 75 mm



Figure 4g. Plug-in adaptor - average dimensions 54 mm dia. x 55 mm

Figure 5 Examples of CFL lampholders

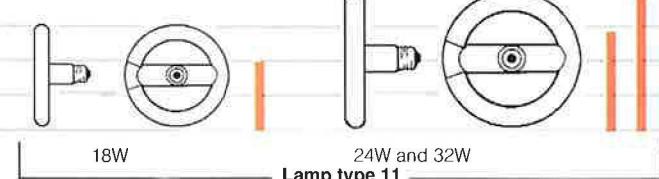
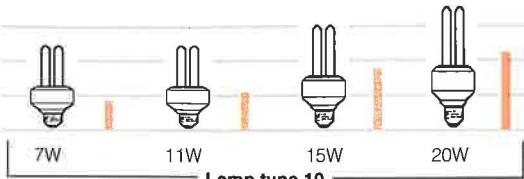


Figure 5a



Figure 5b

DIMENSIONS (MM)	300	L	3000
	250	G	2500
	200	H	2000
	150	O	1500
	100	U	1000
	50	I	500
	0	T	0
		LUMENS	



## SWITCHING CONTROLS, DAYLIGHT AND PRESENCE DETECTORS

Further energy savings can be achieved by utilising some form of switch control, though this should be carefully considered for each application to avoid adversely affecting lamp life by too frequent switching.

Automatic daylight sensors for external lighting (figure 6a) in conjunction with time switches maximise energy savings. For controlling internal lighting where there is a high degree of natural lighting available, daylight sensors (figure 6b) can be used effectively. Presence detectors, which after a set period switch lighting off in the absence of occupants (figure 6c), can be used effectively where lighting is frequently left on when a room is vacated. Note: Control devices must be appropriate for use with CFLs.

With the low cost of running CFLs it is sometimes advisable to leave lights on when they are in areas where security is an issue (such as front doors). Alternatively, standard presence detectors can be used, though in certain set-ups these may be activated inadvertently by passers-by.



Figure 6a



Figure 6b



Figure 6c

Figure 6 Daylight and presence detectors

## WARNING - TESTING

High voltage 'Megger' testing equipment can damage the electronics used with CFLs and therefore, if circuit tests must be carried out, alternative appropriate means should be used.